WSDOT WETLAND MITIGATION SITES

NORTH CENTRAL REGION

MONITORING REPORT

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INTRODUCTION

History

The Washington State Department of Transportation (WSDOT) facilitates responsible implementation of transportation services, in part by providing leadership to foster environmental stewardship. WSDOT strictly adheres to all applicable federal, state and local environmental regulations, including the Clean Water Act and the state "no net loss" policy for wetlands (Executive Order 1989).

Infrastructure improvements have accompanied economic and population growth in the state of Washington. WSDOT routinely evaluates the potential for degradation of critical areas resulting from infrastructure improvements. Generally, mitigation sites are planned when transportation improvement projects affect critical areas. Monitoring provides a means to track the status and development of these mitigation sites. These sites are monitored by the WSDOT Wetland Monitoring Program. Beginning with six sites in 1988, the number of sites monitored annually has grown steadily. Fifty-one sites were monitored in 2000 (Figures 1 and 2).

Purpose

The purpose for this document is to report the status of WSDOT mitigation sites as observed in 2000. Permit compliance and the development of wetland characteristics are addressed as appropriate. We rely on feedback from the users of this report to ensure its contents are clear, concise and meaningful.

Process

Site monitoring typically begins in the first spring after the site is planted. Sites are monitored for the time period designated by the permit or mitigation plan. The monitoring period generally ranges from three to ten years. Monitoring activities may vary depending on site and permit requirements, stage of site development, and other factors.

Data are collected on a variety of site parameters including vegetation, hydrology, and wildlife. Monitoring activities are driven by site-specific success standards detailed in the mitigation plan. Analysis of monitoring data provides information for an evaluation of site development and permit compliance.

Monitoring data has several intended uses, including the following. The monitoring program staff use results from data analysis to communicate issues related to site development and to report compliance to permit success standards to regional staff and permitting agencies. Regional staff uses data provided by the monitoring team to plan appropriate maintenance and remediation activities. Permitting agencies use the data to track and document compliance.

Methods

Methods used for mitigation site monitoring have changed as site requirements and customer needs have evolved. Our historical data collection methods are described in the ***Guide for Wetland Mitigation Project Monitoring*** (Horner and Raedeke 1989). These methods were initially adopted as a standardized set of protocols, with vegetation, hydrology, soil, wildlife and benthic macroinvertebrate data collected on every site, every year.

As the number of sites being actively monitored increased, these standardized protocols have been modified. During this period, program staff began to evaluate monitoring methods used by other groups and agencies. This effort led to a major change in the methods used to monitor WSDOT mitigation sites. The data collection techniques currently in use include standard ecological and biostatistical methods.[1]

There are several important differences between our historical and current monitoring methods. Brief descriptions of these changes follow.

Objective-based monitoring: Instead of routinely collecting data for a wide range of environmental parameters, we presently collect data using a monitoring plan and sampling design developed specifically for that site. The monitoring plan and sampling design address individual requirements such as success standards, site development, invasive species, and other considerations as required.

Adaptive management: Monitoring is a critical component of the adaptive management process, driven by site-specific management objectives that describe a desired condition (Elzinga et al. 1998). Through appropriate sampling design and collection of valid data, monitoring determines if the objectives have been achieved. Monitoring provides the link between objectives and management activities. Without reliable data to accurately identify deficiencies, appropriate corrective management activities cannot be conducted. Alternately, with poor data, unnecessary management may occur.

Statistical rigor: In the analysis of biological data it is common to discover that too few data were collected for reliable conclusions to be drawn (Krebs 1999; Zar 1999). In addition, data must be collected using some type of random sampling procedure (Elzinga 1999). The monitoring program presently uses a variety of tools to remove subjectivity from data collection and to increase the reliability of our results. Our goal is to provide customers with an objective evaluation of site conditions based on valid monitoring data.

[1] New methods combine changes in sampling design with rigorous statistical analysis to more accurately portray vegetative development on mitigation sites. New methods are based on techniques described in Bonham (1989), Elzinga (1998), Krebs (1999), Zar (1999), and other sources.

Success standards: An important element in any mitigation plan is the objectives and success standards (Ossinger 1999). They serve to indicate the desired state or condition of the mitigation site at a given point in time. Some also provide contingencies if a specific condition is met, such as low aerial cover of woody species or exceeding a threshold of invasive species.

Monitoring program staff use the success standards and contingencies as the basis for establishing management objectives for each site. Management objectives are derived directly from the success standards contained in the mitigation plan and/or site permit. In this process, the goals, objectives, and standards for success and site permit are carefully examined to understand the intended site attributes or characteristics. Each management objective contains six required elements; species indicator, location, attribute, action, quantity/status, and time frame (Elzinga 1999). These elements help describe the desired site condition.

Many management objectives require a companion sampling objective. When the management objective identifies a threshold, such as aerial cover or survival rate, the sampling objective includes a confidence level and confidence interval half width.[2] These are noted as ($CI = X \pm Y$), where CI = confidence interval, X = confidence level, and Y = confidence interval half width. For example, should you see an estimated aerial cover of herbaceous species shown as 65% ($CI = 0.80 \pm 0.20$) in a report, this means that we are eighty percent confident that the reported value is within twenty percent of the true value. In this case, our estimated value is sixty-five percent, and we are eighty percent confident the true aerial cover value is between seventy-eight percent and fifty-two percent.

Two examples of how these will appear in the report follow:

From the Mitigation Plan or Permit:

Success Standard
Upland and riparian forested buffer areas should have 50% cover by forested species planted, or be supplemented or replaced by a native naturally colonizing upland forested plant community at 50% or greater cover.

Derived from the Mitigation Plan or Permit:

Management Objective
Achieve 50% aerial cover of forested and scrub-shrub species in the riparian buffer on the SR 18 Issaquah-Hobart mitigation site by 2001.

[2] The confidence level indicates the probability that the confidence interval includes the true value. The confidence interval half width will decrease as the confidence level decreases (Elzinga 1998).

Companion to the Management Objective:

Sampling Objective 2

To be 80% confident the mean aerial cover estimate for forested and shrub species in the riparian buffer is within 20% of the true cover value.

From the Mitigation Plan or Permit:

Contingency Plan

The mitigation plan is designed to use and promote the growth of native vegetation. Attempts will be made to limit the spread of exotic species, which will not be allowed to dominate the site. Noxious weeds will be eliminated immediately if found occurring on the site, before large populations can establish. A weed control program will be implemented if more than 5% of the coverage in the wetland is deleterious exotic species.

Derived from the Contingency Plan:

Management Objective

To maintain the combined level of deleterious exotic species at $\leq 5\%$ aerial cover at the Profitt's Point mitigation site in each year of the monitoring period (2000-2005).

Companion to the Management Objective:

Sampling Objective 3

To be 80% confident that the aerial cover estimate for the combined level of deleterious exotic species is within $\pm$ 20% of the true value.

Mitigation plans and permits frequently contain success standards that are not measurable. One example of this is attempting to measure the survival of woody species in the third year of monitoring. Wetlands are highly productive systems that produce substantial biomass. In most cases, planted woody species that have died cannot be reliably located after three years, and usually will have decayed beyond recognition as a planted species. **Success standards that are not measurable or do not apply to the current year's activities do not have management or sampling objectives in this report.**

The management objectives, sampling objectives, and the success standard from which they were derived are in the text of each site report. The complete objectives and success standards from the mitigation plan for that site are in the appendices of each report.

Intensity of Monitoring

Monitoring is conducted primarily for two purposes (Elzinga et al. 1998). One is to detect biologically significant changes in abundance, condition, or population structure. Estimates of aerial cover and survival of plantings are examples of attributes that can be

measured to detect biologically significant change. The other purpose is to understand the effects of management activities on ecosystems or plant communities.

Parameters for monitoring activities are grouped into two levels, qualitative or quantitative, based on the level of effort or intensity of data collection. Qualitative techniques are generally less intensive than quantitative techniques (Elzinga et al. 1998). Qualitative monitoring provides general information such as presence or absence of specific plant species, hydrology indicators, or assessment of site conditions. Also, photographs are generally taken to document current site conditions. A library of site photographs is available in the program office.

Quantitative monitoring provides information on aerial cover, condition, or site characteristics. Random sampling methods are required to produce a statistically credible estimate of a characteristic when only a portion of a site is sampled (Zar 1999). When practical, a total census gives an accurate count of the population rather than an estimate. A variety of methods and tools are used to collect quantitative data, including the line intercept method (Canfield 1941; Bonham 1989), the point intercept method (Bonham 1989; Elzinga et al. 1998), point-intercept devices, point frames, and others. A detailed description of the specific data collection methods used is included in each site report.

The requirements within the permits and mitigation plan can adequately be addressed qualitatively in some years, and in others, quantitative monitoring is appropriate. If there are success standards for this year of the monitoring period, a report follows in this document. In other cases, qualitative monitoring was conducted, and the results communicated internally to the appropriate environmental manager. This feedback allows the site manager to conduct any corrective activities prior to the time that the next success standard will be quantitatively monitored.

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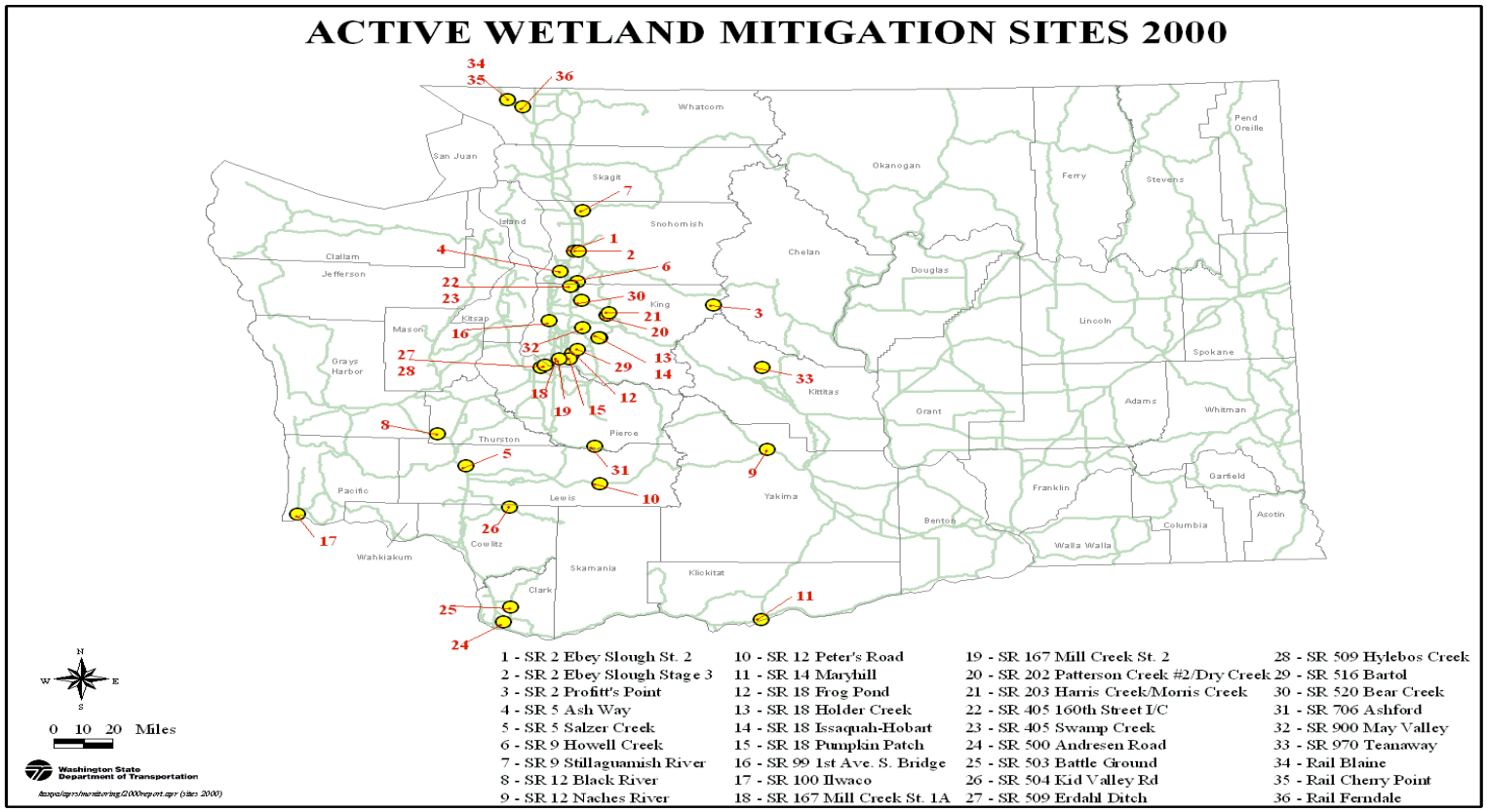

Figure 1: WSDOT Mitigation Sites Monitored in 2000

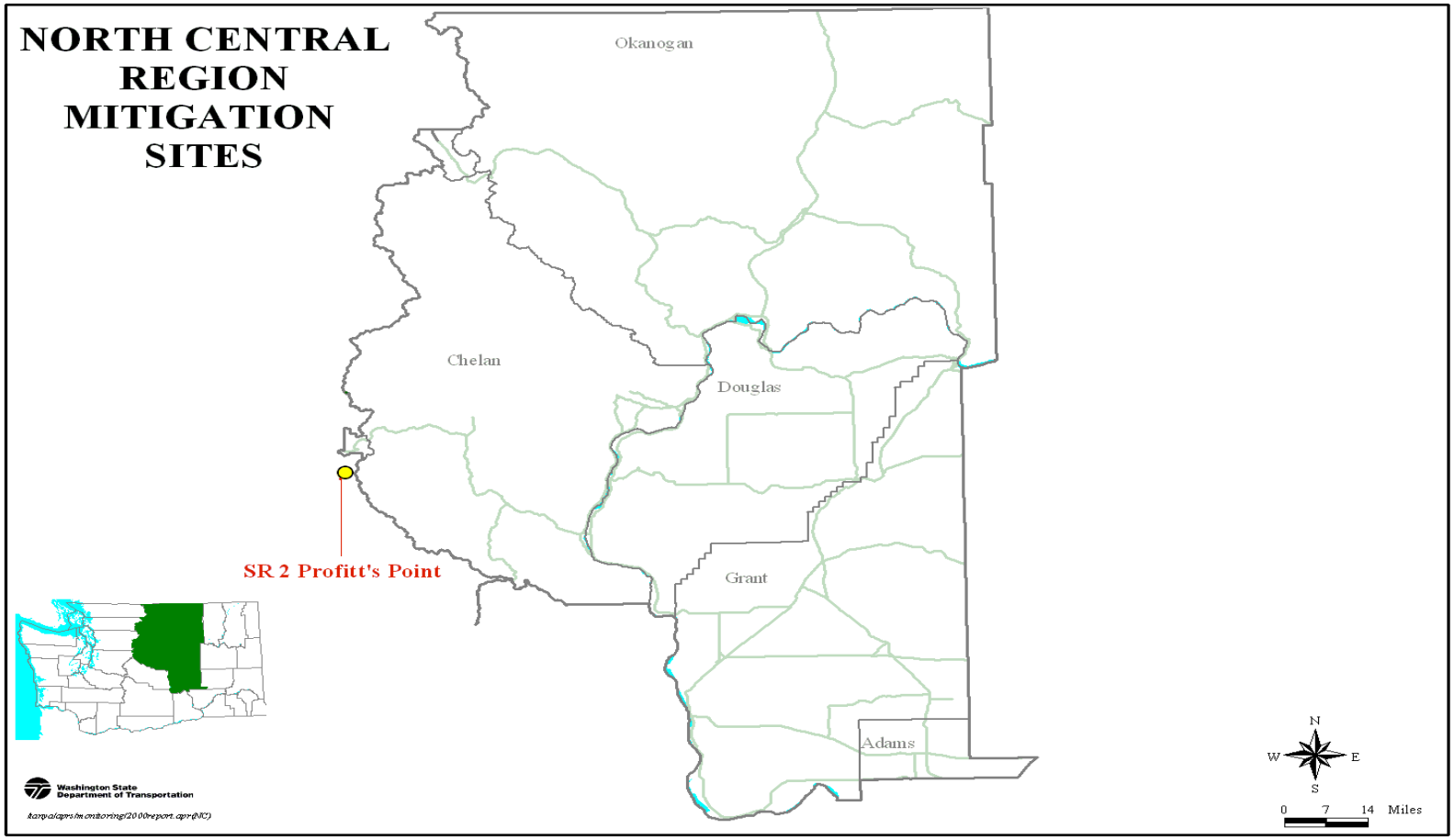

FIGURE 2: North Central Region Mitigation Sites Monitored in 2000

SR 2 Profitt's Point, King County

The following report summarizes monitoring activities completed at the Profitt's Point wetland enhancement mitigation site in July 2000 by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program[3]. Activities include vegetative cover surveys and an evaluation of tree and shrub survival.

Site information

Site Name	SR 2 Profitt's Point
Project Name	Profitt's Point to Deception Creek
Permit Number	L95GL067
Permitting Agency	King County
Location	SR 2, King County, Washington
Township/Range/Section	T26N R12E S25,26,27,28
Monitoring Period	2000 - 2005
Year of monitoring	1 of 5
Area of project impact	0.3 ha (0.8 ac)
Type of mitigation	Wetland Enhancement
Area of Mitigation	0.5 ha (1.1 ac) - wetland enhancement site
Replacement Ratios	2:1

Management and Sampling Objectives

Monitoring objectives were developed from 1st year success standards described in the *Profitt's Point to Deception Creek Project Mitigation Plan* (WSDOT Environmental Affairs Office and North Central Region 1996) and the King County permit (KCDDES 1995). The complete text of the success standards is presented in Appendix A. Success standards, management objectives, and sampling objectives addressed this year are listed below. For management objectives without a corresponding sampling objective, a monitoring strategy is described in the methods section.

Success Standard

Survival of planted material in the wetland is over 90% for trees and shrubs in openings and interplanted conifers on the rest of the site.

Management Objective 1

Achieve 90% survival of planted trees and shrubs in the wetland zone at the Profitt's Point mitigation site during the first year of monitoring (2000).[4]

[3] Monitoring conducted by the WSDOT Monitoring Program is specific to the 1.1 acre wetland enhancement area and does not address other mitigation areas associated with this project.

[4] This management objective addresses those species identified by the mitigation plan planting schedule for the wetland enhancement area (WSDOT Environmental Affairs Office and North Central Region 1996).

Success Standard
Measurements from a manual water level fluctuation gauge indicate that the maximum water depth in lowest areas (outside of drainage courses) in the wetland is greater than 10 cm (4 inches) at least once per year.

Management Objective 2
Achieve a water depth of at least 10 cm on a water depth gauge located in the lowest area of the Profitt's Point mitigation site at least one time in each year of the monitoring period (2000–2005).[5]

Contingency Plan
The mitigation plan is designed to use and promote the growth of native vegetation. Attempts will be made to limit the spread of exotic species, which will not be allowed to dominate the site. Noxious weeds will be eliminated immediately if found occurring on the site, before large populations can establish. A weed control program will be implemented if more than 5% of the coverage in the wetland is deleterious exotic species.

Management Objective 3
To maintain the combined level of deleterious exotic species at $\leq 5\%$ aerial cover at the Profitt's Point mitigation site in each year of the monitoring period (2000-2005).

Sampling Objective 3
To be 80% confident that the aerial cover estimate for the combined level of deleterious exotic species is within $\pm$ 20% of the true value.

Methods
A temporary macroplot was subjectively located within the site boundaries with a 40-m baseline located near the eastern site boundary. Transects were extended perpendicular to the baseline using a systematic random sampling method and terminated at the western site boundary.

A total census of planted woody vegetation was completed to determine survival rate in the wetland zone. Trees and shrubs were assigned a status of alive or dead. Data were summed and a total percent survival value was determined by dividing the total number of living planted trees and shrubs by the total number encountered.

[5] The hydrological performance standard listed under Objective 1 in the mitigation plan (WSDOT Environmental Affairs Office and North Central Region 1996) states alternative success criteria. Evidence of ponded water anywhere on the wetland enhancement site for more than seven consecutive days also satisfies this success standard.

The point intercept technique (Bonham 1989; Elzinga et al. 1998) was used to collect aerial cover data for herbaceous species along each sampling transect. Following a random start, point quadrats were systematically placed at 2.0-m intervals along sampling transects. At each point location, a pin was lowered vertically from above the tallest herbaceous vegetation on the west side of the transect tape. Each plant species intercepted by the pin flag was recorded. If the pin did not intercept vascular plant species, data was recorded as bare soil, non-vascular plant, or habitat structure. To achieve the statistical confidence specified in sampling objective three, data was collected at 749 points along sampling transects.

Sample size analysis of point intercept data confirmed achievement of sampling objective three. The following equation was used to perform this analysis:

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[6]
n = unadjusted sample size

Results and Discussion

Results of a total census of planted material show that management objective one has been achieved (Table 1). The survival rate for planted tree and shrub species is 93%, exceeding the 90% survival criterion.

Monitoring activities for this site commenced late in the spring of the year 2000. A water gauge has been installed at a low point on the site and a measurement of the water level will be recorded in March of 2001.

The aerial cover estimate for deleterious exotic species in the herbaceous plant community was 11% (CI 0.90 ± 0.20) (Table 1). *Geranium robertianum* (Robert geranium) contributes all of this cover and is the single species of concern on site. This species is not considered a noxious weed in King County but is considered undesirable because of the site's close proximity to region six where it is listed as a class B noxious weed (State Noxious Weed List and Schedule of Monetary Penalties 1999). Regional managers have been contacted and weed control is scheduled for spring 2001.

Appendix A includes a list of plant species recorded during monitoring visits to the SR 2 Profitt's Point mitigation site in 2000.

[6] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

Table 1. **Survival estimates for species in the wetland enhancement area show the objective has been achieved for planted tree and shrub survival. Deleterious exotic species aerial cover exceeds the five percent limit.**

Wetland Enhancement Area	Plant Survival (Objective 1)	Undesirable Species (Objective 3)
Total Aerial Cover	**93%**	**11%**
Management Objective	**Achieved**	**Not achieved**
Species	*Abies grandis*	*Geranium robertianum*
	Thuja plicata	
	Cornus sericea	
	Physocarpus capitatus	
	Sambucus racemosa	

Literature Cited

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Appendix A

The following excerpt is from the *Profitt's Point to Deception Creek Project Mitigation Plan* (WSDOT Environmental Affairs Office and North Central Region 1996). The standards and contingency plans addressed this year are identified in **bold** font. Other standards will be addressed in the indicated monitoring year.

Goals, Objectives, and Standards of Success
The primary goal is to enhance an existing low quality wetland. A transition from young deciduous scrub-shrub community to structurally complex forested and scrub-shrub wetland is expected. The enhanced wetland will provide the following functions: wildlife habitat, food-chain support for fish and wildlife, and limited floodwater flow attenuation and water storage. The site is designed to include forest, scrub-shrub, and upland buffer.

The mitigation plan is designed to promote the growth of native vegetation. Attempts will be made to limit the spread of exotic species, which will not be allowed to dominate the site. Noxious weeds will be eliminated immediately if found on the site, before large populations can establish. A weed control program will be implemented if more than 5% of the coverage in the wetland is deleterious exotic species.

Objective 1: Enhance existing wetland by creating spatial openings where conifers and shrubs will be planted and interplant conifers throughout, increasing plant diversity in the short-term and structural diversity over the long-term.

Performance Standard
After one year:
- **Survival of planted material in the wetland is over 90% for trees and shrubs in openings and interplanted conifers on the rest of the site.**

After three years:
- Survival of planted material in the wetland is over 85% for trees and shrubs in openings and over 70% for interplanted conifers on the rest of the site.
- The planted trees and shrubs show measurable growth between annual sampling times based on plant height.
- Delineate at the end of the third year per King County DDES permit.

After five years:
- Survival of planted material in the wetland is over 75% for trees and shrubs in openings and over 60% for interplanted conifers on the rest of the site.
- The planted trees and shrubs show measurable growth between annual sampling times based on plant height.

Objective 2: Hydrology of the site is successfully augmented by holding water for short periods during the spring runoff each year.

Performance Standard

- **Measurements from a manual water level fluctuation gauge indicate that the maximum water depth in lowest areas (outside of drainage courses) in the wetland is greater than 10 cm (4 inches) at least once per year.**

or

There is evidence that water is ponded in any part of the wetland for more than 7 consecutive days per year. Evidence of ponding may be any of the hydrologic indicators of such conditions identified in the US Army Corps of Engineers wetland delineation manual.

Contingency Plans for Deleterious Exotic Species

The mitigation plan is designed to use and promote the growth of native vegetation. Attempts will be made to limit the spread of exotic species, which will not be allowed to dominate the site. Noxious weeds will be eliminated immediately if found occurring on the site, before large populations can establish. A weed control program will be implemented if more than 5% of the coverage in the wetland is deleterious exotic species.

Profitt's Point Plant List 2000

Species Name	Common Name	Status	Origin
Abies grandis	grand fir	NL	Native
Acer circinatum	vine maple	FAC-	Native
Acer macrophyllum	bigleaf maple	FACU	Native
Achillea millefolium	common yarrow	FACU	Native
Agrostis alba	redtop	FAC	Eur
Agrostis capillaris	colonial bentgrass	FAC	Eurasia
Agrostis exarata	spike bentgrass	FACW	Native
Athyrium filix-femina	subarctic lady fern	FAC	Native
Carex deweyana	Dewey's sedge	FACU	Native
Cinna latifolia	slender wood-reedgrass	FACW	Native
Circaea alpina	enchanter's nightshade	NL	NL
Cirsium sp.	thistle	---	---
Claytonia sibirica	western springbeauty	FAC	Native
Cornus sericea	red-osier dogwood	FACW	Native
Dactylis glomerata	orchard grass	FACU	Eur
Elymus glaucus	blue wildrye	FACU	Native
Epilobium ciliatum	hairy willow-herb	FACW-	Native
Equisetum pratense	shady horsetail	FACW	Native
Festuca pratensis	meadow fescue	FACU+	Eur
Festuca rubra	red fescue	FAC+	Native
Fragaria vesca	woodland strawberry	NL	Native
Geranium robertianum	Robert geranium	NL	Eur
Geum macrophyllum	large-leaf avens	FACW-	Native
Holodiscus discolor	ocean spray	NL	Native
Hypericum formosum	St. Johns wort	FAC-	Native
Juncus effusus	soft rush	FACW	Native
Juncus tenuis	slender rush	FACW-	Native
Lactuca mycelis	wall lettuce	NL	Eur
Leucanthemum vulgare	oxeye-daisy	NL	Eur
Lolium perenne	perennial ryegrass	FACU	Eur
Oemleria cerasiformis	Indian plum	FACU	Native
Petasites palmatus	palmate coltsfoot	FAC	Native
Phalaris arundinacea	reed canarygrass	FACW	Nat & Intro
Physocarpus capitatus	Pacific ninebark	FACW-	Native
Plantago major	broadleaf plantain	FACU+	Native
Poa trivialis	rough bluegrass	FACW	Intro
Polystichum munitum	sword fern	FACU	Native
Populus balsamifera	black cottonwood	FAC	Native
Pseudotsuga menziesii	Douglas fir	FACU	Native

Profitt's Point Plant List 2000 (Continued)

Species Name	Common Name	Status	Origin
Rubus parviflorus	western thimbleberry	FAC-	Native
Rubus spectabilis	salmonberry	FAC+	Native
Rubus ursinus	California dewberry	FACU	Native
Sambucus cerulea	blue elderberry	FAC-	Native
Stachys spp.	hedgenettle	---	---
Thuja plicata	western red cedar	FAC	Native
Tolmiea menziesii	piggy-back plant	FAC	Native
Trifolium hybridum	alsike clover	FAC	Intro
Tsuga heterophylla	western hemlock	FACU-	Native
Veronica americana	American speedwell	OBL	Native

Glossary of Terms

Abundance (total) – the total number of individuals, cover, frequency of occurrence, volume, or biomass of a species, or group of species, within a given area.

Accuracy – the closeness of a measured or computed value to its true value.

Adaptive management – the process of linking ecological management within a learning framework.

Aerial cover - is the amount of ground covered by vegetation of a particular species or suite of species when viewed from above. Aerial cover is generally expressed as a percentage. This is typically obtained from herbaceous plot, point intercept, or line intercept data.

Areal estimates - are made using the mapped boundary of a feature as viewed from above. Areal estimates are a measure of area recorded as a number from 0 to 100, and not as a fraction or percent (Hruby et al. 1999). Compare this to the definition of percent cover.

Aquatic vegetation - includes submerged rooted (includes *Elodea, Characeae, Myriophyllum*) or floating non-rooted aquatic plants (includes *Lemna, Azolla, Wolfia*). For compliance purposes, these plants are not included in cover estimates.[7]

Bare ground - an area that can support, but does not presently support vascular vegetation (for compliance purposes, bare ground may include areas covered by cryptogams).

Benthic community - life in or on the sediments of a body of water.

Biological monitoring – the acquisition of information to assess the status and trend in status of the structure and functioning of biological populations and communities, and their habitat, and larger-scale ecological systems over time for the purpose of assessing and directing management activities (Elzinga et al. 1998).

Biological population – all of the individuals of one or more species within a prescribed area at a particular time.

Confidence interval (CI) – is an estimate of precision around a sample mean. A confidence interval includes confidence level and confidence interval half-width.

[7] For compliance purposes, vascular floating-leaved plants are included in cover estimates (e.g., *Nuphar, Potamogeton*).

Glossary (continued)

Canopy cover - the coverage of foliage canopy (herbaceous or woody species) per unit ground area.

Community - a group of populations of species living together in a given place and time.

Cryptogam - any of the *Cryptogamia*, an old primary division of plants comprising those without true flowers and seeds including ferns, mosses, and thallophytes (algae, fungi, and lichen).

Density – the number of individuals, stems, or other counting unit per unit area.

Ecotone - the boundary or transitional zone between adjacent communities.

Emergent plants - erect, rooted, herbaceous angiosperms that may be temporarily to permanently flooded at their base but do not tolerate prolonged inundation of the entire plant.

Floating plant - a non-anchored plant that floats freely in the water or on the water surface.

Floating-leaved plant - a rooted, herbaceous hydrophyte with some leaves floating on the water surface.

Herbaceous - with characteristics of an herb; an annual, biennial, or perennial plant that is leaflike in color or texture, or not woody.

Herbaceous cover - is the estimated aerial cover of herbaceous vegetation on a mitigation site; generally expressed as a percentage. Specifically, it is the proportion of ground covered by the herbaceous layer relative to the proportion of bare ground.

Hydric soils - soils formed under the conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

Line transect – a transect for which the sampling unit is, theoretically, a line with no width.

Macroplot – usually refers to a relatively large sampling area in which subsampling will be conducted, often using quadrats and/or transects.

Management objective – a clear description of a measurable standard, desired state, threshold value, amount of change, or trend that you are trying to achieve for a particular population or habitat characteristic (Elzinga et al. 1998).

Glossary (continued)

Mud flat - a level landform composed of unconsolidated sediments. A mud flat may be irregularly shaped or elongate and continuous with the shore, whereas bars are generally elongate, parallel to the shore, and separated from the shore by water (Cowardin et al. 1979).

Open water - an area intended to be non-vegetated and permanently inundated as described in the site mitigation or planting plan.

Plot - a general term applied to any size of a circumscribed sampling unit for vegetation.

Point frame – is a linear, square, or rectangular quadrat that consists of a number of points used to collect vegetation data.

Point quadrat (points) – is a plot with a very small area, a single point, used to collect vegetation data. The point quadrat is theoretically dimensionless.

Population (biological) – all individuals of one or more species within a specific area at a particular time.

Population (statistical) - the complete set of individual objects (sampling units) about which you want to make inferences.

Precision – the closeness of repeated measurements of the same quantity.

Quadrat - an area delimited for sampling flora or fauna; the sampling frame itself.

Random sampling – sampling units drawn randomly from the population of interest.

Relative abundance (birds) – the number of individuals per unit of sampling effort.

Restricted random sampling – a sampling method that divides the population of interest into equal-sized segments. In each segment, a single sampling unit is randomly positioned. Sampling units are then analyzed as if they were part of a simple random sample.

Sample – a subset of the total possible number of sampling units in a statistical population.

Sample standard deviation – a value indicating how similar each individual observation is to the sample mean.

Sample statistics – are descriptive measures that are estimates of population parameters.

Glossary (continued)

Sampling – the act or process of selecting a part of something with the intent of showing the quality, style, or nature of the whole.

Sampling objective – a clearly articulated goal for the measurement of an ecological condition or change value (Elzinga et al. 1998).

Sampling units – the individual objects that collectively make up a statistical population, e.g., an individual plant, quadrats (plots), points, or transects (lines).

Standard deviation (SD) – a measure of how similar each individual observation is to the overall mean value.

Shrub - a woody plant which at maturity is usually less than 6m (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Species richness (birds) - the total number of bird species observed on a site.

Species richness (plant) - is the total number of species recorded on a site (herbaceous and woody).

Structures - any structure that is not expected to support vegetation in the short-term (during the monitoring period). These structures may include habitat structures, rocks, and other artifacts.

Systematic Random Sampling – the regular placement of quadrats, points, or lines along a sampling transect following a random start.

Transect - a line or narrow belt to survey the distributions or abundance of organisms across an area.

Tree - a woody plant that at maturity is usually 6m (20 feet) or more in height and generally has a single trunk, unbranched for 1m or more above ground, and more or less definite crown (Cowardin et al. 1979). The species categories in this report follow Cooke, 1997.

Vegetation structure - the physical or structural description of the plant life, e.g. the relative biomass (cover) in canopy layers; generally independent of particular species composition.

Wetland-dependent species (birds) - restricted in temporal or spatial distribution to wetlands based on an intrinsic feature or features of the environment (Finch, 1989).

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